



pressure of about seventyfive millimeters, and even at this Very low pressure the discharge of a high-tension induction-coil passes through only a part of the attenuated gas in the form of a luminous thread or are, a still further and considerable diminution of the pressure being required to render the entire mass of the gas inclosed in a vessel conducting. While this is true in every particular so long as electromotive or current impulses such as are obtainable with ordinary forms of apparatus are employed, I have found that neither the general behavior of the gases nor the known relations between electrical conductivity and barometric pressure are in conformity with these observations when impulses are used such as are producible by methods and apparatus devised by me and which have peculiar and hitherto unobserved properties and are of effective electromotive forces, measuring many hundred thousands or millions of volts. Through the continuous perfection of these methods and apparatus and the investigation of the 5c actions of these current impulses I have been unknown. Among these and bearing directly upon the subject of my present application are the following: First, that atmospheric or other gases, even under normal pressure, when they are known to behave as perfect insulators, are in a large measure deprived of their dielectric properties by being subjected to the influence of electromotive impulses of the character and magnitude I have referred to and assume conducting and other qualities which have been so far observed only in gases greatly attenuated or heated to a high temperature, and, second, that the conductivity imparted to the air or gases increases very rapidly both with the augmentation of the applied electrical pressure and with the degree of rarefaction, the law in this latter respect being, however, quite different from that heretofore established. In illustration of these facts a few observations, which I have made with apparatus devised for the purposes here contemplated, may be cited. For example, a conductor or terminal, to which impulses such as those here considered are supplied, but which is otherwise insulated in space and is remote from any conducting-bodies, is surrounded by a luminous flame-like brush or discharge often covering many hundreds or even as much as several thousands of square feet of surface, this striking phenomenon clearly attesting the high degree of conductivity which the atmosphere attains under the influence of the immense electrical stresses to which it is subjected. This influence is, however, not confined to that portion of the atmosphere which is discernible by the eye as luminous and which, as has been the case in some instances actually observed, may fill the space within a spherical or cylindrical envelop of a diameter of sixty feet or more, but reaches out to far remote regions, the insulating quality continuously enlarges as time goes on, and the discharge is allowed to pass not unlike a conflagration which slowly spreads, this being possibly due to the gradual electrification or ionization of the air or to the formation of less insulating gaseous compounds. It is, furthermore, a fact that such discharges of extreme tensions, approximating those of lightning, manifest a marked tendency to pass upward away from the ground, which maybe due to electrostatic repulsion, or possibly to slight heating and consequent rising of the electrified or ionized air. These latter observations make it appear probable that a discharge of this character allowed to escape into the atmosphere from a terminal maintained at a great height will gradually leak through and establish a good conducting-path to more elevated and better conducting air strata, a process which possibly takes place in silent lightning discharges frequently witnessed on hot and sultry days. It will be apparent to what an extent the conductivity imparted to the air is enhanced by the increase of the electromotive force of the impulses when it is stated that in some instances the area covered by the flame discharge mentioned was enlarged more than sixfold by an augmentation of the electrical pressure, amounting scarcely to more than fifty per cent. As to the influence of rarefaction upon the electric conductivity imparted to the gases it is noteworthy that, whereas the atmospheric,

or other gases begin ordinarily to manifest this quality at something like seventy-five millimeters barometric pressure with the impulses of excessive electromotive force to which I have referred, the conductivity, as already pointed out, begins even at normal pressure and continuously increases with the degree of tenuity of the gas, so that at, say, one hundred and thirty millimeters pressure, when the gases are known to be still nearly perfect insulators for ordinary electromotive forces, they behave toward electromotive impulses of several millions of volts like excellent conductors, as though they were rarefied to a much higher degree. By the discovery of these facts and the perfection of means for producing in a safe, economical, and thoroughly-practicable manner current impulses of the character described it becomes possible to transmit through easily-accessible and only moderately-rarefied strata of the atmosphere electrical energy not merely in insignificant quantities, such as are suitable for the operation of delicate instruments and like purin its theoretical aspect and in its practical poses, but also in quantities suitable for industrial uses on a large scale up to practically any amount and, according to all the experimental evidence I have obtained, to any terrestrial distance. To conduce to a better understanding of this method of transmission of energy and to distinguish it clearly, both hearing, from other known modes of transmission, it is useful to state that all previous efforts made by myself and others for transmitting electrical energy to a distance without the use of metallic conductors, chiefly with the object of actuating sensitive receivers, have been based, in so far as the atmosphere is concerned, upon those qualities which it possesses by virtue of its being an excellent insulator, and all these attempts would have been obviously recognized as ineffective if not entirely futile in the presence of a conducting atmosphere or medium. The utilization of any conducting properties of the air for purposes of transmission of energy,

has been hitherto out of the question in the absence of apparatus suitable for meeting the many and difficult requirements, although it has long been known or surmised that atmospheric strata at great altitudes-say fifteen or more miles above sea-level-are, or should be, in a measure, conducting; but assuming even that the indispensable means should have been produced then still a difficulty, which in the present state of the mechanical arts must be considered as insuperable, would remain-namely, that of maintaining terminals at elevations of fifteen miles or more above the level of the sea. Through my discoveries before mentioned and the production of adequate means the necessity of maintaining terminals at such inaccessible altitudes is obviated and a practical method and system of transmission of energy through the natural media is afforded essentially different from all those available up to the present time and possessing, moreover, this important practical advantage, that whereas in all such methods or systems heretofore used or proposed but a minute fraction of the total energy expended by the generator or transmitter was recoverable in a distant receiving apparatus by my method and appliances it is possible to utilize by far the greater portion of the energy of the source and in any locality however remote from the same.

Expressed briefly, my present invention, based upon these discoveries, consists then in producing at one point an electrical pressure of such character and magnitude as to,

cause thereby a current to traverse elevated strata of the air between the point of generation and a distant point at which the energy is to be received and utilized.

. In the accompanying drawing a general arrangement of apparatus is diagrammatically illustrated such as I contemplate employing in the carrying out of my invention on an industrial scale-as, for instance, for lighting distant cities or districts from places where cheap power is obtainable.

Referring to the drawing, A is a coil, generally of many turns and of 'a very large diameter, wound in spiral form either about a magnetic core or not, as may be found necessary. C is a second coil, formed of a conductor of. much larger section and smaller IIO transformer.

length,wound around and in proximity to the coil A. In the transmitting apparatus the coilA constitutes the high-tension secondary and the coil O the primary of much lower tension of a transformer. In the circuit of the primary O is included a suitable source of current G. One terminal of the secondary A is at the center of the spiral coil, and from this terminal the current is led by a conductor B to a terminal D, preferably of large surface, formed or maintained by such means as a balloon at an elevation suitable for the purposes of transmission, as before described. The other terminal of the secondary A is connected to earth and, if desired, also to the primary in order that the latter may be at substantially the same potential as the adjacent portions of the secondary, thus insuring safety. At the receiving-station a transformer of similar construction is employed; but in this case the coil A, of relatively-thin wire, constitutes the primary and the coil O', of thick wire or cable, the secondary of the In the circuit of the latter are included lamps L, motors M, or other devices for utilizing the current. The elevated terminal D is connected with the center. of the coil A, and the other terminal of said coil is connected to earth and preferably, also, to the coil O for the reasons above stated.

It will be observed that in coils of the character described the potential gradually increases with the number of turns toward the center, and the difference of potential between the adjacent turns being comparatively small a very high potential, impracticable with ordinary coils, may be successfully obtained. It will be, furthermore, noted that no matter to what an extent the coils may be modified in design and construction, owing to their general arrangement and manner of connection, as illustrated, those portions of the wire or apparatus which are highly charged will be out of reach, while those parts of the same which are liable to be approached, touched, or handled will be at or nearly the same potential as the adjacent portions of the ground, this insuring, both in the transmitting and receiving apparatus and regardless of the magnitude of the electrical pressure used, perfect personal safety, which is best evidenced by the fact that although such extreme pressures of many millions of volts have been for a number of years continuous-ly experimented with no injury has been sustained neither by myself or any of my assistants.

The length of the thin-wire coil in each transformer should be approximately onequarter of the wave length of the electric disturbance in the circuit, this estimate being based ,on the velocity of propagation of the disturbance through the coil itself and the circuit with which it is designed to be used. By Way of illustration if the rate at which the current traverses the circuit, including the coil, be one hundred and eighty-five thousand miles per second then a frequency of nine hundred and twenty five per second would maintain nine hundred and twenty-five stationary waves in a circuit one hundred and eighty-five thousand miles long-and each wave would be two hundred miles in length. For such a low frequency, to which I shall resort only when it is indispensable to operate motors of the ordinary kind under the conditions above assumed, I would use a secondary of fifty miles in length. By such an adjustment or porportioning of the length of wire in the secondary coil or coils the points of highest potential are made to coincide with the elevated terminals D D, and it should be understood that whatever length be given to the wires this condition should be complied with in order to attain the best results.

I As the main requirement in carrying out my invention is to produce currents of an excessively-high potential, this object will be facilitated by using a primary current of. very considerable frequency, since the electromotive force obtainable with a given length of conductor is proportionate to the frequency; but the frequency of the current is in a large measure arbitrary, for if the potential be sufficiently high and if the terminals of the coils be maintained at the proper altitudes the action described will take place, and a current will be transmitted through the elevated air strata, which will encounter little and possibly even less resistance than if conveyed through a copper wire of a practicable size. Accordingly the construction of the apparatus may be in many details greatly varied; but in order to enable any person skilled in the mechanical and electrical arts to utilize to advantage in the practical applications" of my system the experience I have so far gained the following particulars of a model plant which has been long in use and which was constructed for the purpose of obtaining further data to be used in the carrying out of my invention on a large scale are given. The transmitting apparatus was in this case one of my electrical oscillators, which are transformers of a special type, now well known and characterized by the passage of oscillatory discharges of a condenser through the primary. The source G, forming one of the elements of the transmitter, was a condenser of a capacity of about four one-hundredths of a microfarad and was charged from a generator of alternating currents of fifty thousand volts pressure and discharged by means of a mechanically-operated break five thousand times per second through the primary O. The latter consisted of a single turn of stout stranded cable of inappreciable resistance and of an inductance of about eight thousand centimeters, the diameter of the loop being very nearly two hundred and forty-four centimeters. The total inductance of the primary circuit was approximately ten thousand centimeters, so that the primary circuit vibrated generally. according to adjustment,

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from two hundred and thirty thousand to two hundred and fifty thousand times per second. The high-tension coil A in the form of a flat spiral was composed of fifty turns of heavily insulated cable No. 8 wound in one single layer, the turns beginning close to the primary loop and ending near its center. The outer end of the secondary or high-tension coil A was connected to the ground, as illustrated, while the free end was led to a terminal placed in the rarefied air stratum through which the energy was to be transmitted, which was contained in an insulating-tube of a length of fifty feet or more, within which a barometric pressure varying from about one hundred and twenty to one hundred and fifty millimeters was maintained by means of a mechanical suction-pump. The receiving transformer was similarly proportioned, the ratio of conversion being the reciprocal of that of the transmitter, and the primary high tension coil A was connected, as illustrated, with the end near the low-tension coil to the ground and with the free end to a wire or plate likewise placed in the rarefied air stratum and at the distance named from the transmitting-terminal. The primary and secondary circuits in the transmitting apparatus being carefully synchronized, an electromotive force from two to four million volts and more was obtainable at the terminals of the secondary coil A, the discharge passing freely through the attenuated air stratum maintained at the above barometric pressures, and it was easy under these conditions to transmit with fair economy considerable amounts of energy, such as are of industrial moment, to the receiving apparatus for supplying from it the secondary coil O' lamps L or kindred devices. The results were particularly

satisfactory when the primary coil or system A, with its secondary O, was carefully adjusted, so as to vibrate in synchronism with the transmitting coil system A C. I have, however, found no difficulty in producing with apparatus of substantially the same design and construction electromotive forces exceeding, not so much due to a large ratio of transformation as to the joint effect of the capacities and inductances in the synchronized circuits, which effect is enhanced by a high frequency, and it will be obviously understood that if the latter be reduced a greater ratio of transformation should be resorted to, especially in cases in which it may be deemed of advantage to suppress as much as possible, and particularly in the transmitting-coil A, the rise of pressure due to the above effect and to obtain the necessary electromotive force solely by a large transformation ratio.

While electromotive forces such as are produced by the apparatus just described may be sufficient for many purposes to which my system will or may be applied, I wish to state that I contemplate using in an industrial undertaking of this kind forces greatly in excess of these, and with my present knowledge and experience in this novel field I would estimate them to range from twenty to fifty million volts and possibly more. By the use of these much greater forces larger amounts of energy may be conveyed through the atmosphere to remote places or regions, and the distance of transmission may be thus extended practically without limit.

As to the elevation of the terminals D D it is obvious that it will be determined by a number of things, as by the amount and quality of the work to be performed, by the local density and other conditions of the atmosphere, by the character of the surrounding country, and such considerations as may present themselves in individual instances. Thus if there be high mountains in the vicinity the terminals should be at a greater height, and generally they should always be, if practicable, at altitudes much greater than those of the highest objects near them in order to avoid as much as possible the loss by leakage. In some cases when small amounts of energy are required the high elevation of the terminals, and more particularly of the receiving terminal D, may not be necessary, since, especially when the frequency of the currents is very high, a sufficient amount of energy may be collected at that terminal by electrostatic induction from the upper air strata, which are rendered conducting by the active terminal of the transmitter or through which the currents from the same are conveyed.

With reference to the facts which have been pointed out above it will be seen that the altitudes required for the transmission of considerable amounts of electrical energy in accordance with this method are such as are easily accessible and at which terminals can be safely maintained, as by the aid of captive balloons supplied continuously with gas from reservoirs and held in position securely by steel wires or by any other means, devices, or expedients, such as may be contrived and perfected by ingenious and skilled engineers. From my experiments and observations I conclude that with electromotive impulses not greatly exceeding fifteen or twenty million volts the energy of many thousands of horse-power may be transmitted over vast distances, measured by many hundreds and even thousands of miles, with terminals not more than thirty to thirty-five thousand feet above the level of the sea, and even this comparatively-small elevation will be required chiefly for reasons of economy, and, if desired, it may be considerably reduced, since by such means as have been described practically any potential that is desired may be obtained, the currents through the air strata may be rendered very small, whereby the loss in the transmission may be reduced.

It will be understood that the transmitting as well as the receiving coils, transformers, or other apparatus may be in some cases movable-as, for example, when they are carried by vessels floating in the air or by ships at sea. In such a case, or generally, the connection of one of the terminals of the high tension coil O' to the ground may not be permanent, but may be intermittently or inductively established, and any such or similar modifications I shall consider as within the scope of my invention.

While the description here given contemplates chiefly a method and system of energy transmission to a distance through the natural media for industrial purposes, the principles which I have herein disclosed and the apparatus which I have shown will obviously have many other valuable uses-as, for instance, when it is desired to transmit intelligible messages to great distances, or to illuminate upper strata of the air, or to produce, designedly, any useful changes in the condition of the atmosphere, or to manufacture from the gases of the same products, as nitric acid, fertilizing compounds, or the like, by the action of such current impulses, for all of which and for many other valuable purposes they are eminently suitable, and I do not wish to limit myself in this respect. Obviously, also, certain features of my invention here disclosed will be useful as disconnected from the method itself-as, for example, in

other systems of energy transmission, for

whatever purpose they may be intended, the

transmitting and receiving transformers arranged and connected as illustrated, the feature of a transmitting and receiving coil or conductor, both connected to the ground and to an elevated terminal and adjusted so as to vibrate in synchronism, the proportioning of such conductors or coils; as above specified, the feature of a receiving-transformer with its primary connected to earth and to an elevated terminal and having the operative devices in its secondary, and other features or particulars, such as have been described in this specification or will readily be understood by those skilled in the art. The method hereinbefore described of transmitting electrical energy through the,

natural media, which consists in producing at a generating-station a very high electrical pressure, causing thereby a propagation or flow of electrical energy, by conduction, through the earth and the air strata, and collecting or receiving at a distant point the electrical energy so propagated or caused to flow.

2. The method hereinbefore described of transmitting electrical energy, which consists in producing at a generating-station a very high electrical pressure, conducting the current caused thereby to earth and to a terminal at an elevation at which the atmosphere serves as a conductor therefor, and collecting the current by a second elevated terminal at a distance from the first.

3. The method hereinbefore described of transmitting electrical energy through the natural media, which consists in producing between the earth and a generator-terminal elevated above the same, at a generating-station, a sufficiently-high electromotive force to render elevated air strata

conducting, causing thereby a propagation or flow of electrical energy, by conduction, through the air strata,

' and collecting or receiving at a point distant from the generating station the electrical energy so propagated or caused to flow.

4. The method hereinbefore described of transmitting electrical energy through the natural media, which consists in producing between the earth and a generator-terminal elevated above the same, at a generating-station, a sufficiently-high electromotive force to render the air strata at or near the elevated terminal conducting, causing thereby a propagation or flow of electrical energy, by conduction, through the air strata, and collecting or receiving at a point distant from the generating-station the electrical energy so propagated or caused to flow.

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5. The method hereinbefore described of transmitting electrical energy through the natural media, which consists in producing between the earth and a generator-terminal elevated above the same, at a generating-station, electrical impulses of a sufficiently-high point distant from the generating-station, the energy of the current impulses by means of a circuit synchronized with the impulses.

6. The method hereinbefore described of transmitting electrical energy through the natural media, which consists in producing between the earth and a generator-terminal elevated above the same, at a generating-station, electrical impulses of a sufficiently-high electromotive force to render the air strata at or near the elevated terminal conducting, causing thereby current impulses to pass through the air strata, and collecting or receiving at a point distant from the generating-station the energy of the current impulses by means of a circuit synchronized with the impulses.

7. The method hereinbefore described of transmitting electrical energy through the natural media, which consists in producing between the earth and a generator-terminal elevated above the same, at a generating-station, electrical impulses of a wave length so related to the length of the generating circuit or conductor as to produce the maximum potential at the elevated terminal, and of sufficiently-high electromotive force to render elevated air strata conducting, causing thereby a propagation of electrical impulses through the air strata, and collecting or receiving at a point distant from the generating-station the energy of such impulses by means of a receiving-circuit having a length of conductor similarly related to the wave length of the impulses.

8. The method hereinbefore described of transmitting electrical energy through the natural media, which consists in producing between the earth and a generator-terminal elevated above the same, at a generating-station, a sufficiently-high electromotive force to render elevated air strata conducting, causing thereby a propagation or flow of electrical energy through the air strata, by conduction, collecting or receiving the energy so transmitted by means of a receiving-circuit at a point distant from the generating station, using the receiving-circuit to energize a secondary circuit, and operating translating devices by means of the energy so obtained in the secondary circuit.

9. The method hereinbefore described of transmitting electrical energy through the natural media, which consists in generating current impulses of relatively-low electromotive force at a generating-station, utilizing such impulses to energize the primary of a transformer, generating by means of such primary circuit impulses in a secondary surrounding by the primary and connected to the earth and to an elevated terminal, of sufficiently-high electromotive force to render elevated air strata conducting, causing thereby impulses to be propagated through the air strata, collecting or receiving the energy of such impulses, at a point distant from the generating-station, by means of a receiving-circuit connected to the earth and to an elevated terminal, and utilizing the energy so received to energize a secondary circuit of low potential surrounding the receiving-circuit.

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Witnesses: M. LAWSON DYER, G. W. MARTLING.

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| <a href="#">US8409200B2</a> | 2008-09-03 | 2013-04-02 | Ethicon Endo-Surgery, Inc. | Surgical grasping device                                                                  |
| <a href="#">US8410636B2</a> | 2008-09-27 | 2013-04-02 | Witricity Corporation      | Low AC resistance conductor designs                                                       |
| <a href="#">US8441154B2</a> | 2008-09-27 | 2013-05-14 | Witricity Corporation      | Multi-resonator wireless energy transfer for exterior lighting                            |
| <a href="#">US8461720B2</a> | 2008-09-27 | 2013-06-11 | Witricity Corporation      | Wireless energy transfer using conducting surfaces to shape fields and reduce loss        |
| <a href="#">US8461722B2</a> | 2008-09-27 | 2013-06-11 | Witricity Corporation      | Wireless energy transfer using conducting surfaces to shape field and improve K           |
| <a href="#">US8466583B2</a> | 2008-09-27 | 2013-06-18 | Witricity Corporation      | Tunable wireless energy transfer for outdoor lighting applications                        |
| <a href="#">US8471410B2</a> | 2008-09-27 | 2013-06-25 | Witricity Corporation      | Wireless energy transfer over distance using field shaping to improve the coupling factor |



|                                  |            |            |                                  |                                                                                                                               |
|----------------------------------|------------|------------|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| <a href="#">US8476788B2</a>      | 2008-09-27 | 2013-07-02 | Witricity Corporation            | Wireless energy transfer with high-Q resonators using field shaping to improve K                                              |
| <a href="#">US8482158B2</a>      | 2008-09-27 | 2013-07-09 | Witricity Corporation            | Wireless energy transfer using variable size resonators and system monitoring                                                 |
| <a href="#">US8480657B2</a>      | 2007-10-31 | 2013-07-09 | Ethicon Endo-Surgery, Inc.       | Detachable distal overtube section and methods for forming a sealable opening in the wall of an organ                         |
| <a href="#">US8480689B2</a>      | 2008-09-02 | 2013-07-09 | Ethicon Endo-Surgery, Inc.       | Suturing device                                                                                                               |
| <a href="#">US8487480B1</a>      | 2008-09-27 | 2013-07-16 | Witricity Corporation            | Wireless energy transfer resonator kit                                                                                        |
| <a href="#">WO2013104039A1</a> * | 2012-01-13 | 2013-07-18 | Evoluções Energia Ltda           | Equipment for condensing electric current and equipment for transmitting electric current through air                         |
| <a href="#">US8497601B2</a>      | 2008-09-27 | 2013-07-30 | Witricity Corporation            | Wireless energy transfer converters                                                                                           |
| <a href="#">US8496574B2</a>      | 2009-12-17 | 2013-07-30 | Ethicon Endo-Surgery, Inc.       | Selectively positionable camera for surgical guide tube assembly                                                              |
| <a href="#">US8506564B2</a>      | 2009-12-18 | 2013-08-13 | Ethicon Endo-Surgery, Inc.       | Surgical instrument comprising an electrode                                                                                   |
| <a href="#">US8529563B2</a>      | 2008-08-25 | 2013-09-10 | Ethicon Endo-Surgery, Inc.       | Electrical ablation devices                                                                                                   |
| <a href="#">US8552592B2</a>      | 2008-09-27 | 2013-10-08 | Witricity Corporation            | Wireless energy transfer with feedback control for lighting applications                                                      |
| <a href="#">US8569914B2</a>      | 2008-09-27 | 2013-10-29 | Witricity Corporation            | Wireless energy transfer using object positioning for improved k                                                              |
| <a href="#">US8568410B2</a>      | 2007-08-31 | 2013-10-29 | Ethicon Endo-Surgery, Inc.       | Electrical ablation surgical instruments                                                                                      |
| <a href="#">US8579897B2</a>      | 2007-11-21 | 2013-11-12 | Ethicon Endo-Surgery, Inc.       | Bipolar forceps                                                                                                               |
| <a href="#">US8587155B2</a>      | 2008-09-27 | 2013-11-19 | Witricity Corporation            | Wireless energy transfer using repeater resonators                                                                            |
| <a href="#">US8587153B2</a>      | 2008-09-27 | 2013-11-19 | Witricity Corporation            | Wireless energy transfer using high Q resonators for lighting applications                                                    |
| <a href="#">US8608652B2</a>      | 2009-11-05 | 2013-12-17 | Ethicon Endo-Surgery, Inc.       | Vaginal entry surgical devices, kit, system, and method                                                                       |
| <a href="#">US8610311B1</a>      | 2009-01-27 | 2013-12-17 | Energy Magnification Corporation | Passive power generation system                                                                                               |
| <a href="#">US8629578B2</a>      | 2008-09-27 | 2014-01-14 | Witricity Corporation            | Wireless energy transfer systems                                                                                              |
| <a href="#">US8643326B2</a>      | 2008-09-27 | 2014-02-04 | Witricity Corporation            | Tunable wireless energy transfer systems                                                                                      |
| <a href="#">US8667452B2</a>      | 2011-11-04 | 2014-03-04 | Witricity Corporation            | Wireless energy transfer modeling tool                                                                                        |
| <a href="#">US8669676B2</a>      | 2008-09-27 | 2014-03-11 | Witricity Corporation            | Wireless energy transfer across variable distances using field shaping with magnetic materials to improve the coupling factor |
| <a href="#">US8679003B2</a>      | 2008-05-30 | 2014-03-25 | Ethicon Endo-Surgery, Inc.       | Surgical device and endoscope including same                                                                                  |
| <a href="#">US8686598B2</a>      | 2008-09-27 | 2014-04-01 | Witricity Corporation            | Wireless energy transfer for supplying power and heat to a device                                                             |
| <a href="#">US8692410B2</a>      | 2008-09-27 | 2014-04-08 | Witricity Corporation            | Wireless energy transfer with frequency hopping                                                                               |
| <a href="#">US8692412B2</a>      | 2008-09-27 | 2014-04-08 | Witricity Corporation            | Temperature compensation in a wireless transfer system                                                                        |



|                                   |            |            |                                            |                                                                                      |
|-----------------------------------|------------|------------|--------------------------------------------|--------------------------------------------------------------------------------------|
| <a href="#">US8723366B2</a>       | 2008-09-27 | 2014-05-13 | Witricity Corporation                      | Wireless energy transfer resonator enclosures                                        |
| <a href="#">US8729737B2</a>       | 2008-09-27 | 2014-05-20 | Witricity Corporation                      | Wireless energy transfer using repeater resonators                                   |
| <a href="#">US8772973B2</a>       | 2008-09-27 | 2014-07-08 | Witricity Corporation                      | Integrated resonator-shield structures                                               |
| <a href="#">US8771260B2</a>       | 2008-05-30 | 2014-07-08 | Ethicon Endo-Surgery, Inc.                 | Actuating and articulating surgical device                                           |
| <a href="#">US8828031B2</a>       | 2009-01-12 | 2014-09-09 | Ethicon Endo-Surgery, Inc.                 | Apparatus for forming an anastomosis                                                 |
| <a href="#">US8847548B2</a>       | 2008-09-27 | 2014-09-30 | Witricity Corporation                      | Wireless energy transfer for implantable devices                                     |
| <a href="#">US8888792B2</a>       | 2008-07-14 | 2014-11-18 | Ethicon Endo-Surgery, Inc.                 | Tissue apposition clip application devices and methods                               |
| <a href="#">US8901779B2</a>       | 2008-09-27 | 2014-12-02 | Witricity Corporation                      | Wireless energy transfer with resonator arrays for medical applications              |
| <a href="#">US8901778B2</a>       | 2008-09-27 | 2014-12-02 | Witricity Corporation                      | Wireless energy transfer with variable size resonators for implanted medical devices |
| <a href="#">US8907531B2</a>       | 2008-09-27 | 2014-12-09 | Witricity Corporation                      | Wireless energy transfer with variable size resonators for medical applications      |
| <a href="#">US8906035B2</a>       | 2008-06-04 | 2014-12-09 | Ethicon Endo-Surgery, Inc.                 | Endoscopic drop off bag                                                              |
| <a href="#">US8912687B2</a>       | 2008-09-27 | 2014-12-16 | Witricity Corporation                      | Secure wireless energy transfer for vehicle applications                             |
| <a href="#">US8922066B2</a>       | 2008-09-27 | 2014-12-30 | Witricity Corporation                      | Wireless energy transfer with multi resonator arrays for vehicle applications        |
| <a href="#">US8928276B2</a>       | 2008-09-27 | 2015-01-06 | Witricity Corporation                      | Integrated repeaters for cell phone applications                                     |
| <a href="#">US8933589B2</a>       | 2012-02-07 | 2015-01-13 | The Gillette Company                       | Wireless power transfer using separately tunable resonators                          |
| <a href="#">US8937408B2</a>       | 2008-09-27 | 2015-01-20 | Witricity Corporation                      | Wireless energy transfer for medical applications                                    |
| <a href="#">US8939897B2</a>       | 2007-10-31 | 2015-01-27 | Ethicon Endo-Surgery, Inc.                 | Methods for closing a gastrotomy                                                     |
| <a href="#">US8946938B2</a>       | 2008-09-27 | 2015-02-03 | Witricity Corporation                      | Safety systems for wireless energy transfer in vehicle applications                  |
| <a href="#">US8947186B2</a>       | 2008-09-27 | 2015-02-03 | Witricity Corporation                      | Wireless energy transfer resonator thermal management                                |
| <a href="#">US8957549B2</a>       | 2008-09-27 | 2015-02-17 | Witricity Corporation                      | Tunable wireless energy transfer for in-vehicle applications                         |
| <a href="#">US8963488B2</a>       | 2008-09-27 | 2015-02-24 | Witricity Corporation                      | Position insensitive wireless charging                                               |
| <a href="#">US8986199B2</a>       | 2012-02-17 | 2015-03-24 | Ethicon Endo-Surgery, Inc.                 | Apparatus and methods for cleaning the lens of an endoscope                          |
| <a href="#">US9005198B2</a>       | 2010-01-29 | 2015-04-14 | Ethicon Endo-Surgery, Inc.                 | Surgical instrument comprising an electrode                                          |
| <a href="#">US20150102675A1</a> * | 2013-10-11 | 2015-04-16 | Earth Energies, Inc.                       | Power Receiver for Extracting Power from Electric Field Energy in the Earth          |
| <a href="#">US9028483B2</a>       | 2009-12-18 | 2015-05-12 | Ethicon Endo-Surgery, Inc.                 | Surgical instrument comprising an electrode                                          |
| <a href="#">WO2015066818A1</a>    | 2013-11-08 | 2015-05-14 | The Governors Of The University Of Alberta | Electrical energy transfer                                                           |
| <a href="#">US9035499B2</a>       | 2008-09-27 | 2015-05-19 | Witricity Corporation                      | Wireless energy transfer for photovoltaic panels                                     |
| <a href="#">US9054542B2</a>       | 2010-06-10 | 2015-06-09 | Access Business Group International Llc    | Coil configurations for inductive power transfer                                     |

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|-----------------------------------|------------|------------|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <a href="#">US9049987B2</a>       | 2011-03-17 | 2015-06-09 | Ethicon Endo-Surgery, Inc.  | Hand held surgical device for manipulating an internal magnet assembly within a patient                                        |
| <a href="#">US9065423B2</a>       | 2008-09-27 | 2015-06-23 | Witricity Corporation       | Wireless energy distribution system                                                                                            |
| <a href="#">US20150188364A1 *</a> | 2013-12-27 | 2015-07-02 | Fujitsu Component Limited   | Wireless power receiving apparatus and wireless power transmitting apparatus                                                   |
| <a href="#">US9078662B2</a>       | 2012-07-03 | 2015-07-14 | Ethicon Endo-Surgery, Inc.  | Endoscopic cap electrode and method for using the same                                                                         |
| <a href="#">US9093853B2</a>       | 2008-09-27 | 2015-07-28 | Witricity Corporation       | Flexible resonator attachment                                                                                                  |
| <a href="#">US9106203B2</a>       | 2008-09-27 | 2015-08-11 | Witricity Corporation       | Secure wireless energy transfer in medical applications                                                                        |
| <a href="#">US9105959B2</a>       | 2008-09-27 | 2015-08-11 | Witricity Corporation       | Resonator enclosure                                                                                                            |
| <a href="#">US9143009B2</a>       | 2007-02-01 | 2015-09-22 | The Chamberlain Group, Inc. | Method and apparatus to facilitate providing power to remote peripheral devices for use with a movable barrier operator system |
| <a href="#">US9160203B2</a>       | 2008-09-27 | 2015-10-13 | Witricity Corporation       | Wireless powered television                                                                                                    |
| <a href="#">US9184595B2</a>       | 2008-09-27 | 2015-11-10 | Witricity Corporation       | Wireless energy transfer in lossy environments                                                                                 |
| <a href="#">US9226772B2</a>       | 2009-01-30 | 2016-01-05 | Ethicon Endo-Surgery, Inc.  | Surgical device                                                                                                                |
| <a href="#">US9233241B2</a>       | 2011-02-28 | 2016-01-12 | Ethicon Endo-Surgery, Inc.  | Electrical ablation devices and methods                                                                                        |
| <a href="#">US9246336B2</a>       | 2008-09-27 | 2016-01-26 | Witricity Corporation       | Resonator optimizations for wireless energy transfer                                                                           |
| <a href="#">US9254169B2</a>       | 2011-02-28 | 2016-02-09 | Ethicon Endo-Surgery, Inc.  | Electrical ablation devices and methods                                                                                        |
| <a href="#">US9277957B2</a>       | 2012-08-15 | 2016-03-08 | Ethicon Endo-Surgery, Inc.  | Electrosurgical devices and methods                                                                                            |
| <a href="#">US9287607B2</a>       | 2012-07-31 | 2016-03-15 | Witricity Corporation       | Resonator fine tuning                                                                                                          |
| <a href="#">US9306635B2</a>       | 2012-01-26 | 2016-04-05 | Witricity Corporation       | Wireless energy transfer with reduced fields                                                                                   |
| <a href="#">US9318922B2</a>       | 2008-09-27 | 2016-04-19 | Witricity Corporation       | Mechanically removable wireless power vehicle seat assembly                                                                    |
| <a href="#">US9318257B2</a>       | 2011-10-18 | 2016-04-19 | Witricity Corporation       | Wireless energy transfer for packaging                                                                                         |
| <a href="#">US9314620B2</a>       | 2011-02-28 | 2016-04-19 | Ethicon Endo-Surgery, Inc.  | Electrical ablation devices and methods                                                                                        |
| <a href="#">US9384885B2</a>       | 2011-08-04 | 2016-07-05 | Witricity Corporation       | Tunable wireless power architectures                                                                                           |
| <a href="#">US9396867B2</a>       | 2008-09-27 | 2016-07-19 | Witricity Corporation       | Integrated resonator-shield structures                                                                                         |
| <a href="#">US9404954B2</a>       | 2012-10-19 | 2016-08-02 | Witricity Corporation       | Foreign object detection in wireless energy transfer systems                                                                   |
| <a href="#">US9421388B2</a>       | 2007-06-01 | 2016-08-23 | Witricity Corporation       | Power generation for implantable devices                                                                                       |
| <a href="#">US9427255B2</a>       | 2012-05-14 | 2016-08-30 | Ethicon Endo-Surgery, Inc.  | Apparatus for introducing a steerable camera assembly into a patient                                                           |
| <a href="#">US9442172B2</a>       | 2011-09-09 | 2016-09-13 | Witricity Corporation       | Foreign object detection in wireless energy transfer systems                                                                   |
| <a href="#">US9449757B2</a>       | 2012-11-16 | 2016-09-20 | Witricity Corporation       | Systems and methods for wireless power system with improved performance and/or ease of use                                     |
| <a href="#">US9496921B1</a>       | 2015-09-09 | 2016-11-15 | Cpg Technologies            | Hybrid guided surface wave communication                                                                                       |
| <a href="#">US9515494B2</a>       | 2008-09-27 | 2016-12-06 | Witricity Corporation       | Wireless power system including impedance matching network                                                                     |

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|-----------------------------|------------|------------|----------------------------|---------------------------------------------------------------------------|
| <a href="#">US9544683B2</a> | 2008-09-27 | 2017-01-10 | Witricity Corporation      | Wirelessly powered audio devices                                          |
| <a href="#">US9545290B2</a> | 2012-07-30 | 2017-01-17 | Ethicon Endo-Surgery, Inc. | Needle probe guide                                                        |
| <a href="#">US9572623B2</a> | 2012-08-02 | 2017-02-21 | Ethicon Endo-Surgery, Inc. | Reusable electrode and disposable sheath                                  |
| <a href="#">US9595378B2</a> | 2012-09-19 | 2017-03-14 | Witricity Corporation      | Resonator enclosure                                                       |
| <a href="#">US9601270B2</a> | 2008-09-27 | 2017-03-21 | Witricity Corporation      | Low AC resistance conductor designs                                       |
| <a href="#">US9602168B2</a> | 2010-08-31 | 2017-03-21 | Witricity Corporation      | Communication in wireless energy transfer systems                         |
| <a href="#">US9601266B2</a> | 2008-09-27 | 2017-03-21 | Witricity Corporation      | Multiple connected resonators with a single electronic circuit            |
| <a href="#">US9744858B2</a> | 2008-09-27 | 2017-08-29 | Witricity Corporation      | System for wireless energy distribution in a vehicle                      |
| <a href="#">US9780576B1</a> | 2015-11-05 | 2017-10-03 | Marion Harlan Cates, Jr.   | Resonant inductive coupling extension cord for light emitting diodes      |
| <a href="#">US9780573B2</a> | 2014-02-03 | 2017-10-03 | Witricity Corporation      | Wirelessly charged battery system                                         |
| <a href="#">US9837860B2</a> | 2014-05-05 | 2017-12-05 | Witricity Corporation      | Wireless power transmission systems for elevators                         |
| <a href="#">US9843217B2</a> | 2015-01-05 | 2017-12-12 | Witricity Corporation      | Wireless energy transfer for wearables                                    |
| <a href="#">US9842687B2</a> | 2014-04-17 | 2017-12-12 | Witricity Corporation      | Wireless power transfer systems with shaped magnetic components           |
| <a href="#">US9842688B2</a> | 2014-07-08 | 2017-12-12 | Witricity Corporation      | Resonator balancing in wireless power transfer systems                    |
| <a href="#">US9857821B2</a> | 2013-08-14 | 2018-01-02 | Witricity Corporation      | Wireless power transfer frequency adjustment                              |
| <a href="#">US9857402B2</a> | 2015-09-08 | 2018-01-02 | CPG Technologies, L.L.C.   | Measuring and reporting power received from guided surface waves          |
| <a href="#">US9859707B2</a> | 2014-09-11 | 2018-01-02 | Cpg Technologies, Llc      | Simultaneous multifrequency receive circuits                              |
| <a href="#">US9882397B2</a> | 2014-09-11 | 2018-01-30 | Cpg Technologies, Llc      | Guided surface wave transmission of multiple frequencies in a lossy media |
| <a href="#">US9882436B2</a> | 2015-09-09 | 2018-01-30 | Cpg Technologies, Llc      | Return coupled wireless power transmission                                |
| <a href="#">US9887557B2</a> | 2014-09-11 | 2018-02-06 | Cpg Technologies, Llc      | Hierarchical power distribution                                           |
| <a href="#">US9887558B2</a> | 2015-09-09 | 2018-02-06 | Cpg Technologies, Llc      | Wired and wireless power distribution coexistence                         |
| <a href="#">US9887587B2</a> | 2014-09-11 | 2018-02-06 | Cpg Technologies, Llc      | Variable frequency receivers for guided surface wave transmissions        |
| <a href="#">US9887585B2</a> | 2015-09-08 | 2018-02-06 | Cpg Technologies, Llc      | Changing guided surface wave transmissions to follow load conditions      |
| <a href="#">US9887556B2</a> | 2014-09-11 | 2018-02-06 | Cpg Technologies, Llc      | Chemically enhanced isolated capacitance                                  |
| <a href="#">US9885742B2</a> | 2015-09-09 | 2018-02-06 | Cpg Technologies, Llc      | Detecting unauthorized consumption of electrical energy                   |
| <a href="#">US9892849B2</a> | 2014-04-17 | 2018-02-13 | Witricity Corporation      | Wireless power transfer systems with shield openings                      |
| <a href="#">US9893403B2</a> | 2015-09-11 | 2018-02-13 | Cpg Technologies, Llc      | Enhanced guided surface waveguide probe                                   |
| <a href="#">US9893402B2</a> | 2014-09-11 | 2018-02-13 | Cpg Technologies, Llc      | Superposition of guided surface waves on lossy media                      |
| <a href="#">US9899718B2</a> | 2015-09-11 | 2018-02-20 | Cpg Technologies, Llc      | Global electrical power multiplication                                    |
| <a href="#">US9912031B2</a> | 2013-03-07 | 2018-03-06 | Cpg Technologies, Llc      | Excitation and use of guided surface wave modes on lossy media            |

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|--------------------------------|------------|------------|----------------------------------------------------|----------------------------------------------------------------------------------------------------|
| <a href="#">US9910144B2</a>    | 2013-03-07 | 2018-03-06 | Cpg Technologies, Llc                              | Excitation and use of guided surface wave modes on lossy media                                     |
| <a href="#">US9916485B1</a>    | 2015-09-09 | 2018-03-13 | Cpg Technologies, Llc                              | Method of managing objects using an electromagnetic guided surface waves over a terrestrial medium |
| <a href="#">US9921256B2</a>    | 2015-09-08 | 2018-03-20 | Cpg Technologies, Llc                              | Field strength monitoring for optimal performance                                                  |
| <a href="#">US9923385B2</a>    | 2015-06-02 | 2018-03-20 | Cpg Technologies, Llc                              | Excitation and use of guided surface waves                                                         |
| <a href="#">US9927477B1</a>    | 2015-09-09 | 2018-03-27 | Cpg Technologies, Llc                              | Object identification system and method                                                            |
| <a href="#">US9929721B2</a>    | 2015-10-14 | 2018-03-27 | Witricity Corporation                              | Phase and amplitude detection in wireless energy transfer systems                                  |
| <a href="#">US9941566B2</a>    | 2014-09-10 | 2018-04-10 | Cpg Technologies, Llc                              | Excitation and use of guided surface wave modes on lossy media                                     |
| <a href="#">US9948145B2</a>    | 2011-07-08 | 2018-04-17 | Witricity Corporation                              | Wireless power transfer for a seat-vest-helmet system                                              |
| <a href="#">US9952266B2</a>    | 2014-02-14 | 2018-04-24 | Witricity Corporation                              | Object detection for wireless energy transfer systems                                              |
| <a href="#">US9954375B2</a>    | 2014-06-20 | 2018-04-24 | Witricity Corporation                              | Wireless power transfer systems for surfaces                                                       |
| <a href="#">US9960470B2</a>    | 2014-09-11 | 2018-05-01 | Cpg Technologies, Llc                              | Site preparation for guided surface wave transmission in a lossy media                             |
| <a href="#">US9973037B1</a>    | 2015-09-09 | 2018-05-15 | Cpg Technologies, Llc                              | Object identification system and method                                                            |
| <a href="#">US9991048B2</a>    | 2014-06-24 | 2018-06-05 | The Board Of Trustees Of The University Of Alabama | Wireless power transfer systems and methods                                                        |
| <a href="#">US9997040B2</a>    | 2015-09-08 | 2018-06-12 | Cpg Technologies, Llc                              | Global emergency and disaster transmission                                                         |
| <a href="#">US10001553B2</a>   | 2014-09-11 | 2018-06-19 | Cpg Technologies, Llc                              | Geolocation with guided surface waves                                                              |
| <a href="#">US10018744B2</a>   | 2014-05-07 | 2018-07-10 | Witricity Corporation                              | Foreign object detection in wireless energy transfer systems                                       |
| <a href="#">US10027116B2</a>   | 2014-09-11 | 2018-07-17 | Cpg Technologies, Llc                              | Adaptation of polyphase waveguide probes                                                           |
| <a href="#">US10027177B2</a>   | 2015-09-09 | 2018-07-17 | Cpg Technologies, Llc                              | Load shedding in a guided surface wave power delivery system                                       |
| <a href="#">US10027131B2</a>   | 2015-09-09 | 2018-07-17 | CPG Technologies, Inc.                             | Classification of transmission                                                                     |
| <a href="#">US10033197B2</a>   | 2015-09-09 | 2018-07-24 | Cpg Technologies, Llc                              | Object identification system and method                                                            |
| <a href="#">US10033198B2</a>   | 2014-09-11 | 2018-07-24 | Cpg Technologies, Llc                              | Frequency division multiplexing for wireless power providers                                       |
| <a href="#">US10031208B2</a>   | 2015-09-09 | 2018-07-24 | Cpg Technologies, Llc                              | Object identification system and method                                                            |
| <a href="#">US10062944B2</a>   | 2015-09-09 | 2018-08-28 | CPG Technologies, Inc.                             | Guided surface waveguide probes                                                                    |
| <a href="#">US10063104B2</a>   | 2016-02-08 | 2018-08-28 | Witricity Corporation                              | PWM capacitor control                                                                              |
| <a href="#">US10063095B2</a>   | 2015-09-09 | 2018-08-28 | CPG Technologies, Inc.                             | Deterring theft in wireless power systems                                                          |
| <a href="#">US10063110B2</a>   | 2015-10-19 | 2018-08-28 | Witricity Corporation                              | Foreign object detection in wireless energy transfer systems                                       |
| <a href="#">WO2018157917A1</a> | 2017-02-28 | 2018-09-07 | Toyota Motor Europe                                | Method of aligning electronic circuits and electronic alignment system                             |
| <a href="#">US10075019B2</a>   | 2015-11-20 | 2018-09-11 | Witricity Corporation                              | Voltage source isolation in wireless power transfer systems                                        |
| <a href="#">US10074993B2</a>   | 2014-09-11 | 2018-09-11 | Cpg Technologies, Llc                              | Simultaneous transmission and reception of guided surface waves                                    |
| <a href="#">US10079573B2</a>   | 2014-09-11 | 2018-09-18 | Cpg Technologies, Llc                              | Embedding data on a power signal                                                                   |

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| <a href="#">US10084223B2</a> | 2014-09-11 | 2018-09-25 | Cpg Technologies, Llc        | Modulated guided surface waves                                                                            |
| <a href="#">US10092291B2</a> | 2011-01-25 | 2018-10-09 | Ethicon Endo-Surgery, Inc.   | Surgical instrument with selectively rigidizable features                                                 |
| <a href="#">US10103452B2</a> | 2015-09-10 | 2018-10-16 | Cpg Technologies, Llc        | Hybrid phased array transmission                                                                          |
| <a href="#">US10101444B2</a> | 2014-09-11 | 2018-10-16 | Cpg Technologies, Llc        | Remote surface sensing using guided surface wave modes on lossy media                                     |
| <a href="#">US10098527B2</a> | 2013-02-27 | 2018-10-16 | Ethicon Endo-Surgery, Inc.   | System for performing a minimally invasive surgical procedure                                             |
| <a href="#">US10122218B2</a> | 2015-09-08 | 2018-11-06 | Cpg Technologies, Llc        | Long distance transmission of offshore power                                                              |
| <a href="#">US10135301B2</a> | 2015-09-09 | 2018-11-20 | Cpg Technologies, Llc        | Guided surface waveguide probes                                                                           |
| <a href="#">US10141788B2</a> | 2015-10-22 | 2018-11-27 | Witricity Corporation        | Dynamic tuning in wireless energy transfer systems                                                        |
| <a href="#">US10141622B2</a> | 2015-09-10 | 2018-11-27 | Cpg Technologies, Llc        | Mobile guided surface waveguide probes and receivers                                                      |
| <a href="#">US10158251B2</a> | 2012-06-27 | 2018-12-18 | Witricity Corporation        | Wireless energy transfer for rechargeable batteries                                                       |
| <a href="#">US10175203B2</a> | 2014-09-11 | 2019-01-08 | Cpg Technologies, Llc        | Subsurface sensing using guided surface wave modes on lossy media                                         |
| <a href="#">US10175048B2</a> | 2015-09-10 | 2019-01-08 | Cpg Technologies, Llc        | Geolocation using guided surface waves                                                                    |
| <a href="#">US10187042B2</a> | 2012-01-24 | 2019-01-22 | Philips Ip Ventures B.V.     | Wireless power control system                                                                             |
| <a href="#">US10193595B2</a> | 2015-06-02 | 2019-01-29 | Cpg Technologies, Llc        | Excitation and use of guided surface waves                                                                |
| <a href="#">US10193229B2</a> | 2015-09-10 | 2019-01-29 | Cpg Technologies, Llc        | Magnetic coils having cores with high magnetic permeability                                               |
| <a href="#">US10193394B2</a> | 2012-01-06 | 2019-01-29 | Philips Ip Ventures B.V.     | Wireless power receiver system                                                                            |
| <a href="#">US10205326B2</a> | 2015-09-09 | 2019-02-12 | Cpg Technologies, Llc        | Adaptation of energy consumption node for guided surface wave reception                                   |
| <a href="#">US10230270B2</a> | 2015-09-09 | 2019-03-12 | Cpg Technologies, Llc        | Power internal medical devices with guided surface waves                                                  |
| <a href="#">US10248899B2</a> | 2015-10-06 | 2019-04-02 | Witricity Corporation        | RFID tag and transponder detection in wireless energy transfer systems                                    |
| <a href="#">US10263473B2</a> | 2016-02-02 | 2019-04-16 | Witricity Corporation        | Controlling wireless power transfer systems                                                               |
| <a href="#">US10283952B2</a> | 2017-06-22 | 2019-05-07 | Bretford Manufacturing, Inc. | Rapidly deployable floor power system                                                                     |
| <a href="#">US10312747B2</a> | 2015-09-10 | 2019-06-04 | Cpg Technologies, Llc        | Authentication to enable/disable guided surface wave receive equipment                                    |
| <a href="#">US10314649B2</a> | 2012-08-02 | 2019-06-11 | Ethicon Endo-Surgery, Inc.   | Flexible expandable electrode and method of intraluminal delivery of pulsed power                         |
| <a href="#">US10324163B2</a> | 2015-09-10 | 2019-06-18 | Cpg Technologies, Llc        | Geolocation using guided surface waves                                                                    |
| <a href="#">US10396566B2</a> | 2015-09-10 | 2019-08-27 | Cpg Technologies, Llc        | Geolocation using guided surface waves                                                                    |
| <a href="#">US10408916B2</a> | 2015-09-10 | 2019-09-10 | Cpg Technologies, Llc        | Geolocation using guided surface waves                                                                    |
| <a href="#">US10408915B2</a> | 2015-09-10 | 2019-09-10 | Cpg Technologies, Llc        | Geolocation using guided surface waves                                                                    |
| <a href="#">US10424976B2</a> | 2011-09-12 | 2019-09-24 | Witricity Corporation        | Reconfigurable control architectures and algorithms for electric vehicle wireless energy transfer systems |
| <a href="#">US10447342B1</a> | 2017-03-07 | 2019-10-15 | Cpg Technologies, Llc        | Arrangements for coupling the primary coil to the secondary coil                                          |
| <a href="#">US10498393B2</a> | 2014-09-11 | 2019-12-03 | Cpg Technologies, Llc        | Guided surface wave powered sensing devices                                                               |

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|----------------------------------|------------|------------|-------------------------------|-----------------------------------------------------------------------------------------------------------|
| <a href="#">US10498006B2</a>     | 2015-09-10 | 2019-12-03 | Cpg Technologies, Llc         | Guided surface wave transmissions that illuminate defined regions                                         |
| <a href="#">US10559893B1</a>     | 2015-09-10 | 2020-02-11 | Cpg Technologies, Llc         | Pulse protection circuits to deter theft                                                                  |
| <a href="#">US10559867B2</a>     | 2017-03-07 | 2020-02-11 | Cpg Technologies, Llc         | Minimizing atmospheric discharge within a guided surface waveguide probe                                  |
| <a href="#">US10560147B1</a>     | 2017-03-07 | 2020-02-11 | Cpg Technologies, Llc         | Guided surface waveguide probe control system                                                             |
| <a href="#">US10559866B2</a>     | 2017-03-07 | 2020-02-11 | Cpg Technologies, Inc         | Measuring operational parameters at the guided surface waveguide probe                                    |
| <a href="#">US10574091B2</a>     | 2014-07-08 | 2020-02-25 | Witricity Corporation         | Enclosures for high power wireless power transfer systems                                                 |
| <a href="#">US10581492B1</a>     | 2017-03-07 | 2020-03-03 | Cpg Technologies, Llc         | Heat management around a phase delay coil in a probe                                                      |
| <a href="#">US10630111B2</a>     | 2017-03-07 | 2020-04-21 | Cpg Technologies, Llc         | Adjustment of guided surface waveguide probe operation                                                    |
| <a href="#">US10779882B2</a>     | 2009-10-28 | 2020-09-22 | Ethicon Endo-Surgery, Inc.    | Electrical ablation devices                                                                               |
| <a href="#">US10840707B2</a>     | 2018-08-06 | 2020-11-17 | Robert M. Lyden               | Utility pole with solar modules and wireless device and method of retrofitting existing utility pole      |
| <a href="#">WO2021053502A1</a>   | 2019-09-17 | 2021-03-25 | Folquer Holdings Limited      | Method and apparatus for transmission of electrical energy (embodiments)                                  |
| <a href="#">US10998993B2</a>     | 2015-09-10 | 2021-05-04 | CPG Technologies, Inc.        | Global time synchronization using a guided surface wave                                                   |
| <a href="#">US10998730B1</a>     | 2019-04-26 | 2021-05-04 | NeoVolta, Inc.                | Adaptive solar power battery storage system                                                               |
| <a href="#">US11031818B2</a>     | 2017-06-29 | 2021-06-08 | Witricity Corporation         | Protection and control of wireless power systems                                                          |
| <a href="#">US11139686B2</a>     | 2017-04-13 | 2021-10-05 | Richard Marion Mansell        | System and method for wireless transmission of power                                                      |
| <a href="#">US11207988B2</a>     | 2018-08-06 | 2021-12-28 | Robert M. Lyden               | Electric or hybrid vehicle with wireless device and method of supplying electromagnetic energy to vehicle |
| <a href="#">WO2022130132A1</a>   | 2020-12-18 | 2022-06-23 | Folquer Holdings Limited      | System for transmitting electrical energy                                                                 |
| <a href="#">WO2022197348A1</a>   | 2021-03-19 | 2022-09-22 | Momentum Dynamics Corporation | Modular magnetic flux control                                                                             |
| <a href="#">US11493494B2</a>     | 2018-11-29 | 2022-11-08 | Usa Sands, Llc                | Detection system                                                                                          |
| <a href="#">US11575281B2</a>     | 2017-09-26 | 2023-02-07 | Stryker Corporation           | System and method for wirelessly charging a medical device battery                                        |
| <a href="#">US11588421B1</a>     | 2019-08-15 | 2023-02-21 | Robert M. Lyden               | Receiver device of energy from the earth and its atmosphere                                               |
| <a href="#">IT202100023684A1</a> | 2021-09-14 | 2023-03-14 | Aep Ticketing Solutions S R L | QI COMMUNICATION SYSTEM                                                                                   |
| <a href="#">EP4300771A1</a>      | 2022-06-30 | 2024-01-03 | Gabriel Marius Rus            | Process and installation for global wireless energy transport                                             |
| <a href="#">US11904712B2</a>     | 2022-04-15 | 2024-02-20 | Inductev Inc.                 | Foreign object detection for wireless power transfer systems                                              |
| <a href="#">US12024039B2</a>     | 2021-12-07 | 2024-07-02 | Arnold Chase                  | Vehicle self-centered charging system                                                                     |
| <a href="#">US12136824B2</a>     | 2019-08-15 | 2024-11-05 | Robert M. Lyden               | Device for receiving and harvesting energy from the earth and its atmosphere                              |
| <a href="#">US12160110B2</a>     | 2013-10-11 | 2024-12-03 | Earth Energies, Inc.          | Power receiver for extracting power from electric field energy in the earth                               |
| <a href="#">US12562591B2</a>     | 2019-03-27 | 2026-02-24 | Stryker Corporation           | Autoclavable container for sterilizing a wirelessly chargeable battery                                    |
| Family To Family Citations       |            |            |                               |                                                                                                           |



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|------------------------------------|------------|------------|-----------------------------------------|----------------------------------------------------------------------------------------------|
| <a href="#">US787412A</a> *        | 1900-05-16 | 1905-04-18 | Nikola Tesla                            | Art of transmitting electrical energy through the natural mediums.                           |
| <a href="#">US1266175A</a> *       | 1916-05-06 | 1918-05-14 | Nikola Tesla                            | Lightning-protector.                                                                         |
| <a href="#">US4685047A</a> *       | 1986-07-16 | 1987-08-04 | Phillips Raymond P Sr                   | Apparatus for converting radio frequency energy to direct current                            |
| <a href="#">TW200419966A</a> *     | 2002-08-12 | 2004-10-01 | Mobilewise Inc                          | Enhanced RF wireless adaptive power provisioning system for small devices                    |
| <a href="#">US9705606B2</a> *      | 2005-09-27 | 2017-07-11 | Wi-Charge, Ltd.                         | Directional light transmitter and receiver                                                   |
| <a href="#">US7928900B2</a> *      | 2006-12-15 | 2011-04-19 | Alliant Techsystems Inc.                | Resolution antenna array using metamaterials                                                 |
| <a href="#">US8525097B2</a> *      | 2008-01-03 | 2013-09-03 | Wi-Charge Ltd.                          | Wireless laser system for power transmission utilizing a gain medium between retroreflectors |
| <a href="#">US7967074B2</a>        | 2008-07-29 | 2011-06-28 | Baker Hughes Incorporated               | Electric wireline insert safety valve                                                        |
| <a href="#">US8933594B2</a>        | 2008-09-27 | 2015-01-13 | Witricity Corporation                   | Wireless energy transfer for vehicles                                                        |
| <a href="#">US20110080050A1</a> *  | 2009-10-02 | 2011-04-07 | Ut-Battelle, Llc                        | Systems and Methods for Directional Reactive Power Ground Plane Transmission                 |
| <a href="#">DE102010012363A1</a> * | 2010-03-22 | 2011-09-22 | Erweka Gmbh                             | Disintegration time measuring device with coil and a module for wireless transmission        |
| <a href="#">US9735584B2</a>        | 2013-10-17 | 2017-08-15 | Access Business Group International Llc | Wireless power communication                                                                 |
| <a href="#">US10530177B2</a>       | 2017-03-09 | 2020-01-07 | Cochlear Limited                        | Multi-loop implant charger                                                                   |
| <a href="#">CN110498474A</a> *     | 2018-05-18 | 2019-11-26 | 北京高山源科技有限公司                             | High frequency quantum energy laser hydrotreater                                             |
| <a href="#">PT118959A</a>          | 2023-10-03 | 2025-04-03 | Akhema Unipessoal Lda                   | LONGITUDINAL WAVE COILS, SYSTEMS THAT COMPOSE THEM AND ASSOCIATED USES                       |

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| Publication                 | Publication Date | Title                                                              |
|-----------------------------|------------------|--------------------------------------------------------------------|
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| <a href="#">US787412A</a>   | 1905-04-18       | Art of transmitting electrical energy through the natural mediums. |
| <a href="#">US676332A</a>   | 1901-06-11       | Apparatus for wireless telegraphy.                                 |
| <a href="#">Fessenden</a>   | 1908             | Wireless telephony                                                 |
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| <a href="#">US995588A</a>   | 1911-06-20       | Electric-wave transmission.                                        |
| <a href="#">CA2707290A1</a> | 2012-01-12       | Electromagnet                                                      |
| <a href="#">US717511A</a>   | 1902-12-30       | Method of tuning vertical wire oscillators.                        |
| <a href="#">US586193A</a>   | 1897-07-13       | transmitting electrical signals                                    |
| <a href="#">US1382590A</a>  | 1921-06-21       | Submarine wireless system                                          |
| <a href="#">US377879A</a>   | 1888-02-14       | Telegraphy                                                         |



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| <a href="#">Erskine-Murray</a> | 1913       | A handbook of wireless telegraphy: its theory and practice; for the use of electrical engineers, students, and operators |
| <a href="#">US763345A</a>      | 1904-06-21 | Means for tuning and adjusting electric circuits.                                                                        |
| <a href="#">US717771A</a>      | 1903-01-06 | Signaling system.                                                                                                        |
| <a href="#">US717509A</a>      | 1902-12-30 | Apparatus for relaying space-telegraph signals.                                                                          |
| <a href="#">US706740A</a>      | 1902-08-12 | Wireless signaling.                                                                                                      |
| <a href="#">US510612A</a>      | 1893-12-12 | System of telegraphy                                                                                                     |
| <a href="#">Sewall</a>         | 1903       | Wireless telegraphy: its origins, development, inventions, and apparatus                                                 |
| <a href="#">US777014A</a>      | 1904-12-06 | Apparatus for transmitting and receiving signals.                                                                        |
| <a href="#">US915993A</a>      | 1909-03-23 | Wireless telegraphy.                                                                                                     |
| <a href="#">Stroud</a>         | 1910       | Newcastle-on-Tyne Local Section. Inaugural address by the Chairman                                                       |
| <a href="#">US1080544A</a>     | 1913-12-09 | Wireless signaling system.                                                                                               |
| <a href="#">US1006635A</a>     | 1911-10-24 | Space telephony.                                                                                                         |
| <a href="#">US750496A</a>      | 1904-01-26 | Ho model                                                                                                                 |
| <a href="#">USRE12168E</a>     | 1903-11-10 | fessenden                                                                                                                |

Priority And Related Applications

Applications Claiming Priority (3) ▲

| Application   | Filing date | Title |
|---------------|-------------|-------|
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Concepts ▲

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